JOINT RISK MANAGEMENT SECTION

Canadian Institute of Actuaries
Casualty Actuarial Society
Society of Actuaries

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Risk management

Actuaries
Risk is Opportunity.®

Risk management

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ARTICLES NEEDED FOR RISK MANAGEMENT

Your help and participation is needed and welcomed. All articles will include a byline to give you full credit for your effort. If you would like to submit an article, please contact Ross Bowen, editor, at Ross.Bowen@allianzlife.com

The next issues of *Risk Management* will be published:

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PREFERRED FORMAT

In order to efficiently handle articles, please use the following format when submitting articles:

- Word document
- Article length 500-2,000 words
- Author photo (quality must be 300 DPI)
- Name, title, company, city, state and email
- One pull quote (sentence/fragment) for every 500 words
- Times New Roman, 10-point
- Original PowerPoint or Excel files for complex exhibits

If you must submit articles in another manner, please call Kathryn Baker, 847.706.3501, at the Society of Actuaries for help.

Please send an electronic copy of the article to:

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Remembering a Devoted Volunteer and Friend

By Bob Wolf and Steve Siegel

On behalf of the Editors of Risk Management

AS WE OPEN OUR FIRST 2010 ISSUE, we are moved to step back and reflect on the history of this newsletter.

That history is due in no small part to a long-time devoted colleague and friend. With this in mind, the editors wish to dedicate this issue to the memory of Hubert Mueller (1960-2009), a pioneer in Risk Management and one of the founders of this section.

Hubert was an original—he worked tirelessly to raise awareness of ERM across industries and promote the value of ERM in our business, public and even personal lives. He was instrumental in the founding of the SOA/CAS/CIA Joint Risk Management Section and was one of the first actuaries to receive the Chartered Enterprise Risk Analyst (CERA) designation. Hubert was a co-author on many of the early ERM white papers, particularly on Economic Capital, that are still widely read today and are included as sample reading material for the international CERA curriculum. A dedicated and active industry volunteer, he participated on numerous committees, task forces, and section councils including but not limited to:

- Joint Risk Management Section Council
- International Section Council
- Investment Section Council
- Spring Meetings Program Committee
- Annual Meeting Program Committee
- Risk Management Research Team
- Risk Management Continuing Education Team
- Extreme Value Models Task Force
- Policyholder Behavior in the Tail Task Force
- Enterprise Risk Management and Best Practices Task Force

In all of his volunteer work, he brought an enthusiasm and attention to detail that were greatly appreciated by his fellow committee and team members. In particular, Hubert played an instrumental role in making the Enterprise Risk Management (ERM) Symposium the grand event it is today. In recognition of this, the ERM Research Excellence Award that is presented each year to the best overall paper submitted in conjunction with the ERM Symposium has been renamed by the Actuarial Foundation to **"ERM Research Excellence Award in Memory of Hubert Mueller."**

Besides Susan, his loving wife of 22 years, he is survived by his two daughters, Stefanie and Christine Mueller.

We will always remember Hubert as a great role model and friend. ✦

Hubert Mueller

Turning Our Challenges Into Opportunities

By Matthew Clark

I AM LOOKING FORWARD TO SERVING THE JOINT RISK MANAGEMENT Section Council as the chair over the next year. We all have to thank the prior chair Don Mango and the prior editor of the newsletter Sim Segal for an incredible year. The evolution of the newsletter and the evolution of the section have positioned us to meet the needs of the members for years to come.

The past 12 months have presented many challenges. While the world has changed, the insurance industry has been tested and survived. Now, will we emerge stronger? Will we learn from the past and apply that knowledge to the future? When we look back at the recent economic events, what footprint will risk management leave?

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For those of you not yet a member of the INARM list serve, you are missing out on discussions about issues facing the industry and the world. I truly believe that venues like the list serve are key to the evolution of risk management.

The recent economic challenges have increased the attention on risk management in the insurance industry. This is where we have the opportunity to become stronger. It is time to bridge the gap between designing and integrating a risk management function into the strategic decisions made by management. The recent events have elevated the need for insurers to understand and prepare for the risks they face. On a positive note, risk *is* opportunity. While many of the practical uses of risk quantification center around current and evolving regulatory needs, risk management does provide a competitive advantage to those who understand and integrate into strategic decisions. As risk practitioners, we are well positioned to fill this need.

The regulatory front is evolving as well. Globally, the reserve (IFRS, FAS 157 and VACARVM) and capital (Solvency II, C3P2 and C3P3) changes are leveraging stochastic modeling techniques. These changes validate the techniques risk practitioners have employed in risk quantification.

These changes have increased the need for practitioners with the skill sets needed to implement and manage stochastic valuation and risk platforms. The success of the Chartered Enterprise Risk Analyst (CERA) credential has been exciting. History was made in November 2009 when 14 actuarial organizations from around the world signed a global treaty establishing the CERA credential as the globally recognized Enterprise Risk Management (ERM) credential. This is the first time in any profession that multiple organizations have banded together to offer their members and candidates a specialized credential.

I am excited to serve the section as the chair over the next year. We have survived and are getting stronger! ✦

Fourth Year a Home Run for ERM Symposium Scientific Papers Track

By Steven C. Siegel

SINCE 2006, a call for ERM related research papers has been issued in conjunction with the ERM Symposium. The goal of the call for papers has been to provide a forum for the very latest in ERM thinking and move forward principles-based research. The 2009 Call for Papers, the fourth in the series, once again provided an opportunity for thought leaders and innovators to share their ideas and push the boundaries of ERM. I am pleased to report that the 2009 ERM Symposium Scientific Paper Track represents another success in this series in terms of both quality and scope of papers.

Fred Tavan, chair of the ERM Symposium Call for Papers

With Max Rudolph, who had the original idea for the Call for Papers, handing over the chair role to Fred Tavan, over 40 abstracts were reviewed. The breadth of topics submitted reconfirmed the cross-industry interest in this area. The Papers Review Committee included returning members Maria Coronado, Krzysztof Jajuga, Barbara Scott, Dan Oprescu, Nawal Roy, Matthieu Royer, Greg Slone, Richard Targett, Fred Tavan, Al Weller and Robert Wolf as well as newcomers David Cummings, Riaan DeJongh, Wayne Fisher, and Valentina Isakina. Choosing from among the abstracts for nine presentation slots at the symposium required a great deal of review and careful consideration. Given the quality and number of abstracts, as in previous years, the committee wished there were more speaking slots available.

The final task of the committee was to select the prize winning papers. The three prizes awarded at the symposium are: the Actuarial Foundation ERM Research Excellence Award for Best Overall Paper; the PRMIA Institute Award for New Frontiers in Risk Management and the Joint Risk Management Section Award for Practical Risk Management Applications.

The award winners along with the paper abstracts are shown below. Awards were presented at the ERM Symposium Opening session held on April 30, 2009.

2009 ACTUARIAL FOUNDATION ERM RESEARCH EXCELLENCE AWARD FOR BEST OVERALL PAPER:

"A Risk Management Tool for Long Liabilities: The Static Control Model" by John Manistre

John Manistre (right) accepts the fourth annual Actuarial Foundation award from Cecil Bykerk.

ABSTRACT

This paper looks at the problem of valuing and managing the Asset/Liability Management (A/LM) risks associated with insurance liabilities that are too long to be matched by available investments. Two very different approaches to the problem are explored. The first approach called Yield Curve Extension starts with a number of simple ideas for extrapolating a yield curve and analyzes them from a risk management perspective. The paper concludes that these methods lead to unnecessarily extreme A/LM strategies. The paper then describes a second approach called the Static Control Model which allows one to use a total return vehicle as part of the A/LM strategy. The model decomposes a long liability into fixed income and total return components in a market consistent way. The fixed income component is a static hedge for the

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liability in the sense that it matches the first order sensitivities of the model liability as observable market information changes. The paper concludes by arguing that the Static Control Model leads to more useful A/LM strategies for long liabilities.

2009 PRMIA INSTITUTE AWARD FOR NEW FRONTIERS IN RISK MANAGEMENT:

"Risk Factor Contributions in Portfolio Credit Risk Models" by Dan Rosen and David Saunders

Dan Rosen (left) and David Saunders (right) accept PRMIA Institute award from Steve Lindo (center)

ABSTRACT

Determining contributions to overall portfolio risk is an important topic in financial risk management. At the level of positions (instruments and subportfolios), this problem has been well studied, and a significant theory has been built, in particular around the calculation of marginal contributions. We consider the problem of determining the contributions to portfolio risk of risk factors, rather than positions. This problem cannot be addressed through an immediate extension of the techniques employed for position contributions, since, in general, the portfolio loss is not a linear function of the risk factors. We employ the Hoeffding decomposition of the loss random variable into a sum of terms depending on the factors. This decomposition restores linearity, at the cost of including terms that arise from the joint effect of more than one factor. The resulting cross-factor terms provide useful information to risk managers, since the terms in the Hoeffding decomposition can be viewed as best quadratic hedges of the portfolio loss involving instruments of increasing complexity. We illustrate the technique on multi-factor models of portfolio credit risk, where systematic factors may represent different industries, geographical sectors, etc.

2009 JOINT RISK MANAGEMENT SECTION AWARD FOR PRACTICAL RISK MANAGEMENT APPLICATIONS:

"Risk and Light" by David Ingram

David Ingram (right) accepts Joint Risk Management Section award from Mike Hale

ABSTRACT

"In the Kingdom of the Blind, the One Eyed Man is King" — Erasmus, Adagia

It is widely reported that markets are made because different market participants have different views of the opportunities in the market. For every transaction, there may be an agreement on price, but an inevitable complete disagreement on direction of the next move in price. This article examines one source of those differences of opinion in the market: the view of risk of the various market participants. Based on some popular theoretical approaches to risk, a possible range of types of approach to risk is posited that is tied to some popular theoretical approaches to risk. The impact of these views of risk on the types of transactions chosen is extrapolated from groupings of risk views along that range. Finally, the interaction in the market of those varying points of view is illustrated with a simplified example; extension to a fully realistic real world situation is discussed. Simply stated, the article shows how market participants' view of risk impacts not just their own choices, but also how they impact on everyone else's choices as well.

We wish to thank all the organizations and committee members for their support and for making The ERM Symposium a success. ✦

The Law of Risk and Light

By David Ingram

Editor's Note: This article originally appeared in the September/October 2009 issue of Contingencies. *It has been reprinted here with permission.*

"In the country of the blind, the one-eyed man is king."
—Erasmus, *Adagia*

IT'S WIDELY REPORTED THAT MARKETS are made because participants have different views of the opportunities in the market. For every transaction, there may be an agreement on price but also an inevitable complete disagreement on the direction of the next move in price. One source for these differing opinions is the differing views of risk held by various market participants. In this article, I'll take a look at five common perspectives on risk and see how they affect not just each participant's own choices but everyone else's choices, as well.

FIVE COMMON VIEWS OF RISK

1. EYES SHUT—Some risk-takers firmly believe that real rewards come only to those who take risks blindly; they think that caution, preparation and analysis will generally result in avoiding those opportunities that have the best payoffs. Many successful entrepreneurs share this eyes-shut view. They are often the visionaries who stick to their dream in the face of all the naysayers. Are these people phenomenally talented, or just lucky? Even if the eyes-shut entrepreneurs follow completely random strategies, one out of 100 might be wildly successful. That one will be celebrated in the press, while the 99 losers are quickly forgotten. Perhaps some of these individuals are indeed transcendentally talented, but I will proceed under the assumption that there are too few such supermen to worry about.

2. QUICK LOOK—These risk-takers apply an approach that is tried and true, often based on practical rules of thumb. If the situation is familiar, they immediately turn to their usual method of risk selection. Unfamiliar risks are rejected, generally without further thought or analysis. The reward for the quick-look view of risk is often relatively low. But the risk is generally low, as well.

3. ONE-EYED—This perspective adopts a single specific quantitative measure of risk. The two most common examples are volatility and ruin probability. Defining risk as volatility is the basis for modern portfolio theory, the Black-Scholes-Merton model and pricing methods based on risk margin as a function of standard deviation. The ruin theory (or cost of risk capital) approach defines risk (or capital) as a function of the loss potential in an extremely remote situation.

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4. TWO-EYED—In this blended approach, the risk-taker seeks compensation for both volatility and the possibility of ruin— or at least seeks to avoid extremes of one or the other.

5. MULTIDIMENSIONAL—Risk managers with a multidimensional view consider volatility, ruin and everything in between. In addition, they consider risk factors such as parameter risk, correlation, market cycles, liquidity and execution risk. They include not only types of risk that are readily quantifiable but also those that may be extremely difficult to measure. The choice of which view of risk is the best isn't immediately obvious. There are several strengths and weaknesses to each approach, as summarized in Table 1.

Table 1: Strengths and Weaknesses of Various Risk Views

RISK VIEW	STRENGTH	WEAKNESS
Eyes Shut	Low Cost. High Reward.	Low Predictability. High Failure rate.
Quick Look	Reliable. Proven.	Declining / fluctuating returns due to forces outside of field of view. May miss non-traditional risks.
One-Eyed	Can readily develop and explain risk reward trade-offs.	Expensive. Choices will eventually tend toward aspects of risk that are not covered by the single view.
Two-Eyed	Two views of risk just might take care of most of the risk.	Which two views will be the most important?
Multidimensional	Never have to say you are sorry.	Very expensive.

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Each risk view will tend to drive the firm's risk portfolio in a certain direction. Most important, risks that are "in the light" (i.e., recognized by the prevailing risk view) will be managed, mitigated or avoided, while risks that remain "in the dark" (i.e., unrecognized by the prevailing risk view) will tend to accumulate, generally without adequate compensation. This can be summarized as:

The Law of Risk and Light

- Risks in the light shrink, risks in the dark grow;
- Return for risks in the light shrinks faster than the risk;
- Return for risks in the dark doesn't grow as fast as the risk.

A closely related law is:

Gresham's Law of Risk

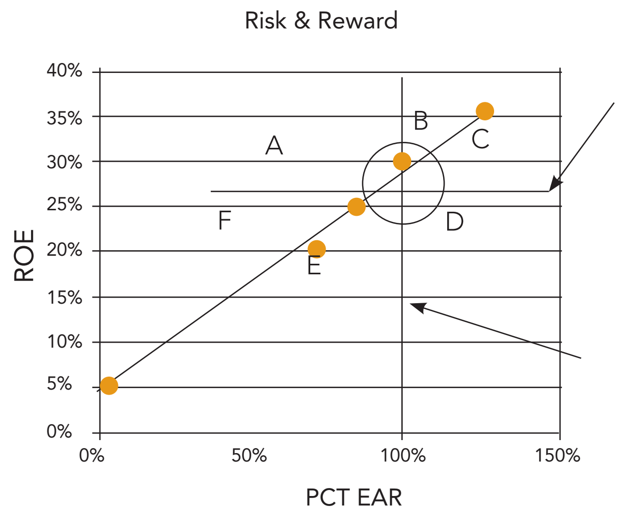
- Those who don't see a risk will drive those who do see the risk out of the market.

Gresham's law is, of course, the same as the adage, "Bad money will drive out good." The varying risk views affect the types of transactions that are likely between counterparties with different risk views. Since five risk views were defined, there are 20 counterparty pairs that can be formed in a two-way transaction. I'll examine a few examples of the counterparty effects using three risk views: one-eyed (volatility), one-eyed (ruin) and two-eyed.

MARKET EFFECTS

Think of Figure 1 as representing the space of all risk and reward choices that are possible to these three market participants. The vertical axis shows the expected reward as a percentage of the ruin estimate. The horizontal axis represents the expected reward as a percentage of volatility. The vertical line at the 100 percent mark represents a hypothetical minimum target for the one-eyed (volatility) risk manager and the horizontal line slightly above the 25 percent mark is a hypothetical minimum target for a one-eyed (ruin) risk manager. The diagonal line represents a very hypothetical target for the two-eyed risk view—different weights on volatility vs. ruin would affect the slope and position of the line.

Figure 1:
Viability of Transaction Depends on Risk View



With these three lines, the risk universe is divided up into six regions, labeled A through F. The one-eyed(volatility) risk view favors risks that are in areas B, C and D. The one-eyed (ruin) risk view favors risks in areas A, B and C. The two-eyed risk view favors risks in areas F, A, and B. Since the ruin and volatility risk views overlap in areas B and C, then that is where they are likely to find agreements as counterparties. The two-eyed risk manager finds agreement with the one-eyed (ruin) risk manager for risks in areas A and B, but only in area B with the one-eyed (volatility) player. In this case, agreement can only be found in areas A, B and C.

THE INFLUENCE OF COMPETITION

As mentioned earlier, financial market theories often assume that the market is completely immune to any influence of the participants. In some situations, that's just not the case for risk transactions. The participants often do seem to affect the market, and diverse risk views may play a major role. Again using the graph, the evolution of the market and the working of Gresham's law can be seen to operate in much the same way as a natural progression of types of trees in a forest. For example, consider a market where long positions are dominated by two-eyed risk managers. Only risks that are priced to fall into areas F, A and B will be taken up. In order to exit a risk position, the risk-holder will need to pay enough risk premium to put the risk into F, A or B. The risk premium is seen here to be a function of both volatility and ruin.

If a one-eyed (volatility) player enters this market, he will take on the risks in areas C and D that the two-eyed risk manager finds inadequately priced. This new player has now changed a significant part of the market. He has split the market with the two-eyed player and lowered the cost of risk to the part of the market with lower volatility and higher ruin.

This illustrates both Gresham's law and the law of risk and light. The volatility risk view doesn't see ruin, so it drives the two-eyed player out of the ruin-concentrated part of the market. Since ruin risk is in the dark for the one-eyed (volatility) player, his share of that risk grows. Since he isn't asking to be paid for it, the implied spread for ruin risk in the market shrinks.

In a market where the two participants hold the one-eyed (volatility) and the one-eyed (ruin) risk views, the result is stark. The one-eyed (volatility) view looks for risks in areas B, C and D, and the one-eyed (ruin) view looks for A, B and C. Prices for deals with more volatility and less ruin risk will be bid down to area C by the one-eyed (volatility) player, where the one-eyed (ruin) view will not take them; deals with more ruin and less volatility would be bid down to area A by the oneeyed (ruin) player, where the one-eyed (volatility) view would shun them. This may be great for the risk sellers, but it guarantees that the two one-eyed players will be subject to a maximum dose of the law of risk and light.

One defense against this situation would be for the one-eyed (ruin) player to convert the one-eyed (volatility) viewer to his point of view. If successful in converting everyone to the ruin risk view, the market will shift from a competition between risk views to a competition on the basis of other advantages (such as size). Further into the future, the regime of a pure ruin view would come to an end when one of the losers in the competition "discovers" the one-eyed (volatility) view of risk and easily starts to find a large target market that is mispriced by one-eyed (ruin) viewers.

THE CREDIT CRISIS AND SOLVENCY II

The collateralized debt obligation (CDO) market prior to the credit crisis provides a stark example of the law of risk and light. Some market participants were clearly operating under a one-eyed view of risk that was focused on volatility with no regard whatsoever for ruin risk. They effectively drove any one-eyed (ruin) players, any two-eyed market and ruin players, and all multidimensional players completely out of the market. The ruin risk that they weren't looking at was in the dark: It grew unchecked as the CDO market came to include more and more sub-prime mortgages. It was obvious that ruin wasn't a concern when the mortgage market participants stopped even trying to collect the information that would allow them to know the loan-to-value or coverage ratio for the mortgagees.

The new European insurance prudential regulatory system (Solvency II) requires all insurers to focus on their ruin risk. (It might seem that Basel 2 has the same effect, but there must be some definitional misunderstanding by either the bankers or their regulators about what the term "ruin" means.) The insurance markets in which European insurers participate may evidence shifts as described above for market participants focused on one-eyed (ruin).

It also would seem possible that European or other insurers who develop a two-eyed risk view will easily be able to find opportunities that the vast majority of one-eyed (ruin) market participants will not be able to discern.

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Since shortterm ruin is the accepted definition of risk under Solvency II, that risk is in the light and firms will seek to shrink their exposure to it. Other risks that will not register as significant under Solvency II may end up in the dark and will therefore grow until they provide an unpleasant surprise.

There's clearly a need for future discussion on the implications of large-scale shifts in risk views. It's quite possible that some portion of market disruptions can be explained by large-scale shifts in risk views such as are likely to happen under Solvency II.

In classical microeconomics, markets are made because buyers and sellers have different utility functions. The person with the powerful car who resents its low fuel efficiency would be best off selling it to a person who values its acceleration capabilities. Neither person has a right or wrong view; each just has different preferences. So it seems to be for risk. Some people have a risk view that emphasizes one aspect of risk; some have a view that emphasizes another. As I have shown, markets are made by the interactions of these risk views that buyers and sellers bring to the market. However, some of these different views are in fact financially dangerous when they involve only limited views of risk. The additional danger comes from the risks in the dark that will always grow until they generate large enough losses to demand attention. ✦

Should Actuaries Get Another Job?
Nassim Taleb's work and it's significance for actuaries

By Alan Mills

INTRODUCTION

Nassim Nicholas Taleb is not kind to forecasters. In fact, he states—with characteristic candor—that forecasters are little better than "fools or liars," that they "can cause more damage to society than criminals," and that they should "get another job."[1] Because much of actuarial work involves forecasting, this article examines Taleb's assertions in detail, the justifications for them, and their significance for actuaries. Most importantly, I will submit that, rather than search for other employment, perhaps we should approach Taleb's work as a challenge to improve our work as actuaries. I conclude this article with suggestions for how we might incorporate Taleb's ideas in our work.

Drawing on Taleb's books, articles, presentations and interviews, this article distills the results of his work that apply to actuaries. Because his focus is the finance sector, and not specifically insurance or pensions, the comments in this article relating to actuarial work are mine and not Taleb's. Indeed, in his work Taleb only mentions actuaries once, as a model for the wrong kind of forecaster (the pathetic Dr. John in The Black Swan). Concerning insurance and pensions, in Fooled by Randomness, he writes derisively, "… pension funds and insurance companies in the United States and in Europe somehow bought the argument that 'in the long term equities always pay off 9%' and back it up with statistics." We may safely conclude that actuaries are not Taleb's heroes.

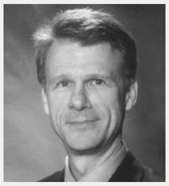
Be forewarned: it is not easy to reach the germ of Taleb's ideas, partly because Taleb himself—and, by extension, his writing—is unusually multilayered, complex, and, yes, entertaining. Perhaps more importantly, though, it is not easy to communicate paradigm-shifting ideas. As one critic stated, "His writing is full of irrelevances, asides and colloquialisms, reading like the conversation of a raconteur rather than a tightly argued thesis."[2] Since Taleb says that his hero of heroes is Montaigne, it is hardly surprising that his style is that of a raconteur, mixing autobiographical material, philosophy, narrative fiction, and history with science and statistics. Indeed, Taleb calls himself a literary essayist and epistemologist.[3] But he is also a researcher, a professor of Risk Analysis, and a former Wall Street trader specializing in derivatives, as well as a polyglot (but because he was born in Lebanon, and grew up partly in France, he is naturally more comfortable in Arabic and French than English.) He characterizes his books The Black Swan and Fooled by Randomness as literary works, rather than technical expositions, and he encourages serious students to read his scholarly works (many of which are referenced on his Web site, www.FooledByRandomness.com). I concur.

Perhaps we should pay attention

"Taleb has changed the way many people think about uncertainty, particularly in the financial markets. His book, *The Black Swan*, is an original and audacious analysis of the ways in which humans try to make sense of unexpected events."
Danel Kahneman, Nobel Laureate
Foreign Policy July/August 2008

"I think Taleb is the real thing. … [he] rightly understands that what's brought the global banking system to its knees isn't simply greed or wickedness, but—and this is far more frightening—intellectual hubris."
John Gray, British philosopher
Quoted by Will Self in *Nassim Taleb*
GQ May 2009

"Taleb is now the hottest thinker in the world. … with two books—*Fooled by Randomness: The Hidden Role of Chance in the Markets and in Life,* and *The Black Swan*—and a stream of academic papers, he turned himself into one of the giants of modern thought."
Brian Appleyard
The Sunday Times June 1, 2008



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WE ARE SUCKERS

Taleb's main point is that our most important financial, political and other social decisions are based on forecasts that share a fatal flaw, thus leading to disastrous consequences. Or, as he says more concisely, "We are suckers." His contribution is to vividly and vociferously expose this flaw, and then suggest how to mitigate its negative impact.

Specifically, Taleb says that forecasts are flawed when applied to support decisions in the "fourth quadrant." He divides the decision-making domain into four quadrants, as shown in Table 1.[4]

Table 1: Four quadrants of the decision-making domain

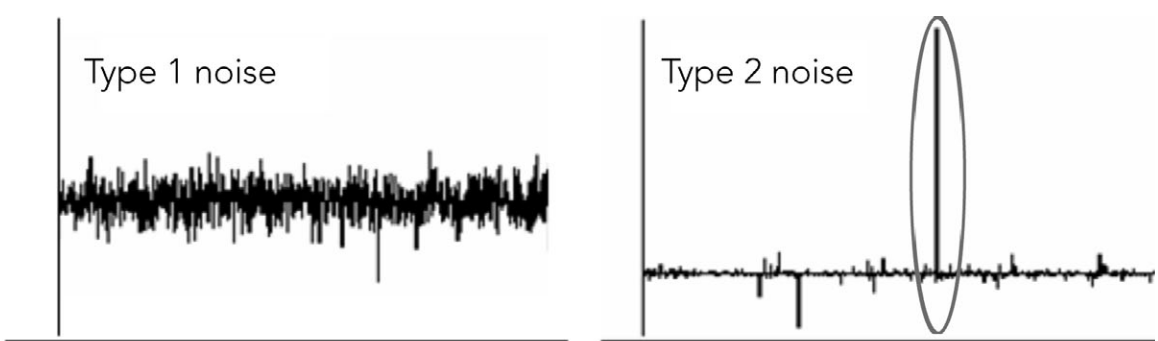
Underlying probability distribution	Payoff	
	Simple (binary)	Complex
Type I	I (safe)	II (safe)
Type II	III (safe)	IV (dangerous)

Taleb divides the decision-making domain according to whether the decision payoff, or result, is simple or complex, and whether the underlying probability distribution (or frequency) of relevant events on which the decision is based is Type I or Type II.

Simple payoffs are binary, true or false. For example, to determine headcounts for a population census, it only matters whether a person is alive or dead. Very alive or very dead does not matter. Simple payoffs only depend on the zeroth moment, the event probability. (In a moment, we'll look at the importance of moments.) For complex payoffs, frequency and magnitude both matter. Thus, with complex payoffs, there is another layer of uncertainty. Actuarial work typically supports decisions with complex payoffs, such as decisions related to medical expenditures, life insurance proceeds, property and casualty claims, and pension payouts. For complex payoffs with linear magnitudes, payoffs depend on the first moment, whereas for non-linear magnitudes (such as highly-leveraged reinsurance) higher moments are important.

Borrowing from the work of Benoit Mandelbrot, Taleb divides probability distributions into Type I and Type II (Mandelbrot calls them, respectively, mild chance and wild chance[5]). Type I distributions are thin-tailed distributions common to the Gaussian family of probability distributions (normal, Poisson, etc.). Type II distributions are fat-tailed distributions (such as Power-law, Pareto, or Lévy distributions). Type II distributions are commonly found in complex adaptive systems such as social economies, health care systems, and property/casualty disasters (earthquakes, hurricanes, etc.) .[6] Importantly, for fat-tailed distributions, higher moments are often unstable over time, or are undefined; they are wildly different from thin-tailed distribution moments. And, for Type II distributions, the Central Limit Theorem fails: aggregations of fat-tailed distributions are often fat-tailed.[4]

Figure 1: Type 1 (Gaussian) noise and Type 2 (Power-law) noise



> "Any system susceptible to a Black Swan will eventually blow up."
> —*Nassim Taleb*

Figure 1 (on page 12) illustrates the difference between Type 1 and Type 2 distributions. On the left is Type 1 noise (white noise) which is Gaussian distributed. On the right is Type 2 noise (typical of electronic signal noise) which is Power-law distributed. The striking difference between the two is that Type 2 noise has one spike of extreme magnitude that dwarfs all other events, and that is not predictable. This spike is a Black Swan. Such Type 2 patterns are typical of complex adaptive systems.

Thus, the problematic fourth quadrant refers to decision making where payoffs are complex (i.e., not binary) and underlying probability distributions are fat-tailed and wild. In this area, according to Taleb, our forecasts fail: they cannot predict events that have massively adverse (or positive) consequences (the Black Swans). Because most decisions in our world fall squarely in the fourth quadrant, most actuarial work supports fourth quadrant decision making and is subject to the forecasting flaw.

To support his thesis, Taleb cites numerous instances when we have been suckers, when dire consequences flowed from our inability to forecast in the fourth quadrant, among which are the collapse of the Soviet Union, U.S. stock market collapses, and the current financial crisis. He also observes that in the areas of security analysis, political science and economics, no one seems to be checking forecast accuracy (see the sidebar).

Although the consequences have not yet been as dramatic as those cited by Taleb, many actuarial forecasts are notorious for their inaccuracy. For example, actual 1990 Medicare costs were 7.39 times higher than original projections.[7] More recently, CMS reports that one-year NHE drug trend projections during 1997-2007 missed actual trends by 2.7 percent *on average*.[8] And, although experience studies are certainly more prevalent in actuarial work than in security analysis, political science or economics, in many areas of actuarial work we are perhaps also negligent in assessing and reporting our prediction accuracy.

The scandal of prediction

Writing about forecasting in security analysis, political science and economics:

"I am surprised that so little introspection has been done to check on the usefulness of these professions. There are a few—but not many—formal tests in three domains: security analysis, political science and economics. We will no doubt have more in a few years. Or perhaps not—the author of such papers might become stigmatized by his colleagues. Out of close to a million papers published in politics, finance and economics, there have been only a small number of checks on the predictive quality of such knowledge. … Why don't we talk about our record in predicting? Why don't we see how we (almost) always miss the big events? I call this the scandal of prediction."

Nassim Taleb
The Black Swan

WHY FORECASTS FAIL

Taleb gives three interrelated reasons why our fourth quadrant forecasts (and, thus, decisions based on these forecasts) fail:

1. Our minds have significant cognitive biases that cloud our ability to reason accurately.
2. We do not understand that our world is increasingly complex and unpredictable.
3. Our forecasting methods are inappropriate for quadrant IV decisions.

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Cognitive biases

Drawing on the work of behavioral economists, evolutionary psychologists, and neurobiologists, Taleb takes considerable pains to demonstrate that human mental makeup is not suitable for dealing with important decisions in the modern world. He shows that we have significant cognitive biases that cloud our reasoning ability, such as:

Confirmation bias: Humans focus on aspects of the past that conform to our views, and generalize from these to the future. We are blind to what would refute our views. We only look for corroboration. This is the central problem of induction: we generalize when we should not. For example, as actuaries, we often base our expenditure projections on a couple of years of recent data from limited sources that conform to our expectations.

Narrative bias: People like to fabricate stories, to weave narrative explanation into a sequence of historical facts, and thereby deceive ourselves that we understand historical causes and effects and can apply this understanding to the future. This bias gives us a false sense of forecasting confidence, a sense that the world is less random and complex than it really is—a complacency leading to forecast error. As actuaries, we think we understand trend drivers, when perhaps we really do not.

Survivorship bias: We follow what we see, because it happened to survive. We don't follow the alternatives that did not have the luck to survive, even though they may be superior.[9] As actuaries, we often use the actuarial methods that continue to be used by our colleagues, even though other methods may be superior.

Tunneling: We focus on a few well-organized sources of knowledge, at the expense of others that are messy or do not easily come to mind. For example, it is not common to find actuaries who perform complete risk analyses, running through an exhaustive set of potentially harmful scenarios. In the main, we stay to well-worn paths, the tried and true. This is natural. As Taleb says, "The dark side of the moon is harder to see; beaming light on it costs energy. In the same way, beaming light on the unseen is costly in both computational and mental effort."[1]

Misunderstanding our complex unpredictable world

As scientists are coming to realize, we live in a world more and more characterized by complex adaptive systems that are on the edge of chaos[10]. A corollary to this realization is that more and more modern decisions are in Quadrant IV, because complex adaptive systems are replete with Type 2 probability distributions, and because modern decisions typically have complex payoffs.

The key point about complex adaptive systems is that their behavior is not forecastable over more than a short time horizon. For example, we cannot forecast weather for more than 14 days, or even the trajectories of billiard balls on a table (see sidebar on next page). Even less can

All the cognitive biases are one idea

"You can think about a subject for a long time, to the point of being possessed by it. Somehow you have a lot of ideas, but they do not seem explicitly connected; the logic linking them remains concealed from you. Yet you know deep down that all these are *the same idea.*

[One morning] I jumped out of bed with the following idea: *the cosmetic and the Platonic rise naturally to the surface.* This is a simple extension of the problem of knowledge. … This is also the problem of silent evidence. It is why we do not see Black Swans: we worry about those that happened, not those that may happen but did not. It is why we Platonify, liking known schemas and well-organized knowledge—to the point of blindness to reality. It is why we fall for the problem of induction, why we confirm. It is why those who 'study' and fare well in school have a tendency to be suckers for the ludic fallacy. And it is why we have Black Swans and never learn from their occurrence, because the ones that did not happen were too abstract.

We love the tangible, the confirmation, … the pompous Gaussian economist, the mathematical crap, the pomp, the Académie Française, Harvard Business School, the Nobel Prize, dark business suits with white shirts and Ferragamo ties, … Most of all, we favor the narrated.

Alas, we are not manufactured, in our current edition of the human race, to understand abstract matters … we are naturally shallow and superficial—and we do not know it.

Nassim Taleb
The Black Swan

> "The world we live in is vastly different from the world we think we live in."
> —*Nassim Taleb*

we forecast complex social systems where the vagaries of human desire are involved. Yet, we continue to act as if events in our world are forecastable, and we base our important decisions on flawed forecasts. As our world becomes increasingly interconnected and complex, our forecasting flaws become more consequential. "The gains in our ability to model (and predict) the world may be dwarfed by the increases in its complexity."[1]

Inappropriate forecasting methods

Taleb's ludic fallacy is that we use Quadrant I and II statistical methods to prepare forecasts for Quadrant IV decisions. Ludic comes from ludus, Latin for "game." Because of familiarity and tractability, we use forecasting methods based on our knowledge of games of chance—methods and analyses largely based on the Gaussian family of probability distributions that are appropriate for Quadrants I and II—to generate forecasts for Quadrant IV decisions, a domain where such methods are completely inappropriate. These methods—including such esteemed methods as value-at-risk, Extreme Value Theory, modern portfolio management, linear regression, other least-squares methods, methods relying on variance as a measure of dispersion, Gaussian Copulas, Black-Sholes, and GARCH—are incapable of prediction where fat-tailed distributions are concerned. Part of the problem is that these methods miscalculate higher statistical moments (which, as we saw above, matter a great deal in the Quadrant IV), and thus lead to catastrophic estimation errors. And, of course, the point is not that we need better forecasting methods in Quadrant IV, the point is that no method will work for more than a short time horizon.

Poincaré's three body problem and the limits of prediction

"As you project into the future you may need an increasing amount of precision about the dynamics of the process that you are modeling, since your error rate grows very rapidly. The problem is that near precision is not possible since the degradation of your forecast compounds abruptly—you would eventually need to figure out the past with infinite precision. Poincaré showed this in a very simple case, famously known as the "three body problem." If you have only two planets in a solar-style system, with nothing else affecting their course, then you may be able to indefinitely predict the behavior of these planets, no sweat. But add a third body, say a comet, ever so small, between the planets. … Small differences in where this tiny body is located will eventually dictate the future of the behemoth planets.

Our world, unfortunately, is far more complicated than the three body problem; it contains far more than three objects. We are dealing with what is now called a dynamical system. … In a dynamical system, where you are considering more than a ball on its own, where trajectories in a way depend on one another, the ability to project into the future is not just reduced, but is subjected to a fundamental limitation. Poincaré proposed that we can only work with qualitative matters—some properties of systems can be discussed, but not computed. You can think rigorously, but you cannot use numbers. … Prediction and forecasting are a more complicated business than is commonly accepted, but it takes someone who knows mathematics to understand that. To accept it takes both understanding and courage."

Nassim Taleb
The Black Swan

RETHINKING OUR APPROACH

Rather than get new jobs, perhaps we can accept Taleb's work as a challenge to rethink how we approach our work. This section summaries Taleb's suggestions for correcting faulty forecasts, and their application to actuaries:

1. Correct our cognitive biases

Taleb suggests several ways to correct our cognitive biases:

Confirmation bias: Use the method of conjecture and refutation introduced by Karl Popper: formulate a conjecture and search for observations that would prove it wrong. This is the opposite of our search for confirmation. For actuaries, this might mean casting wider nets: using much larger data samples over much longer time periods to form our opinions, and seriously searching for counterexamples to our preliminary results.

Narrative bias: Favor experimentation over stories, the empirical over the narrative. For actuaries, this means that we should consider performing controlled experiments (as behavioral economists are doing) to tease out causes and effects, and that we should carefully record the accuracy of our predictions. We should avoid thinking that our correlation studies provide meaningful insights into causality.

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Actuaries in the womb of Mediocristan

(In *The Black Swan*, Taleb calls Quadrants I and II "Mediocristan," a place where Gaussian distributions are applicable. By contrast, he calls Quadrant IV "Extremistan.")

"Actuaries like to build their models on the Gaussian distribution. When they make 40-year projections for Medicare and Social Security solvency, sign Schedule B's for airline and steel company defined benefit pension plans, or do cash flow testing for life insurance company solvency, they aren't displaying professional expertise as much as they are fooling themselves by retreating to the comfort and safety of the womb of Mediocristan. That's what they learned in the agonizing process of studying for those exams. And it's easier to double your 25-year projection for the price of oil than to quit your job and admit that what you've learned and devoted your life to is largely nonsense."

Gerry Smedinghoff
Contingencies May/June 2008

Survivorship bias: Open the mind to alternatives that are not readily apparent and that may not have had the good fortune to survive, and adopt a skeptical attitude towards popular truths. Are our current actuarial methods really the best?

Tunneling: Train ourselves to explore the unexplored. As actuaries, perhaps we could make a greater effort—perhaps using new tools such as data mining—to make sense of our messy data.

2. Study the increasing complexity and unpredictability of our world

To appreciate the complexity and unpredictability of our world, it helps to read a lot and to dispassionately observe the behavior of complex adaptive systems such as stock markets:

- Taleb provides excellent bibliographies in his works. He reads voraciously (60 hours a week) and lists the best resources in his bibliographies. For example, *The Black Swan's* bibliography lists about 1,000 references. Those related to complexity and unpredictability include the works listed in footnotes six and 11 through 16. [6, 11-16]
- He also suggests that we "study the intense, uncharted, humbling uncertainty in the markets as a means to get insights about the nature of randomness that is applicable to psychology, probability, mathematics, decision theory, and even statistical physics."[1]

I would add that it helps to learn from agent-based simulation models of relevant complex adaptive systems. The purpose of such models is not to predict, but rather to learn about potential behaviors of complex systems.[17]

3. Mitigate forecast errors and their impact

Taleb's suggestions to mitigate forecast errors fall into three classes:

- **Use forecasting methods appropriate to the quadrant.** In Quadrant IV, it is best to not even try to predict. The best we can do is apply Mandelbrotian fractal models (which are based on Power laws) to better understand the behavior of Black Swans.[18] Mandelbrotian models will not help with prediction, but they aid our understanding. According to Taleb:

> "… we use Power laws as risk-management tools; they allow us to quantify sensitivity to left- and right-tail measurement errors and rank situations based on the full effect of the unseen. We can effectively get information about our vulnerability to the tails by varying the Power-law exponent alpha and looking at the effect on the moments or the shortfall (expected losses in excess of some threshold). This is a fully structured stress testing, as the tail exponent alpha decreases, all possible states of the world are encompassed. And skepticism about the tails can lead to action and allow ranking situations based on the fragility of knowledge."[19]

In the other quadrants, our common Gaussian-based models do just fine. But simple models are generally better than complicated ones.

- **Be transparent and provide full disclosure.** Once we understand that we cannot accurately predict in Quadrant IV, we need to communicate this to those who rely on our work. Even though actuaries must provide point

"When institutions such as banks optimize, they often do not realize that a simple model error can blow through their capital (as it just did)."
—Nassim Taleb

predictions in order to price insurance products, determine funding amounts, etc., we can effectively communicate our ignorance of the future by providing rigorous experience studies and confidence intervals around our predictions (ideally based on Power law distributions). As Taleb says, "Provide a full tableau of potential decision payoffs," and "rank beliefs, not according to their plausibility, but by the harm they may cause."[1]

- **Exit Quadrant IV.** Because Quadrant IV is where Black Swans lurk, if possible we should exit the quadrant. Although we can attempt to do this through payoff truncation (reinsurance and payoff maximums) and by changing complex payoffs to more simple payoffs (reducing leverage), nevertheless we often remain stuck in Quadrant IV. For example, health insurers try to exit Quadrant IV by reinsuring individual medical expenditures; but, they neglect to purchase aggregate catastrophic reinsurance, and so ignore the fact that aggregations of fat-tailed distributions are themselves fat-tailed distributions, and so remain in Quadrant IV.

Taleb also suggests that organizations should introduce buffers of redundancy "by having more idle 'inefficient' capital on the side. Such 'idle' capital can help organizations benefit from opportunities."[4] Unfortunately, again using health insurers as examples, as companies grow larger, it appears that their capitalization is becoming thinner. Also, contrary to common wisdom, as such companies grow, they more thoroughly optimize their financial operations and thus generally become more susceptible to Black Swans.

One final piece of advice from Taleb: "Go to parties! … casual chance discussions at cocktail parties—not dry correspondence or telephone conversations—usually lead to big breakthroughs."[1] ✦

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FreeCell[1] and Risk Identification

By Steve Craighead

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'FreeCell' is a wonderful game of computer solitaire that comes with the Microsoft Windows operating environment. The goal of the game is to move all of the cards off of the tableau, sorting them by suit into increasing order. The game also has four temporary locations in which a card may be placed.

Even though this game is not as complex as risk identification it does point out several major strategies required.

Obviously, the first requirement in this game is to know the rules. Your knowledge of what the goal is, how to reach it, what your resource limitations are, and how the separate positions on the tableau interact. Regarding risk identification:

- Understanding a risk requires you to remain up to date with your peers, reading, and thinking. Obtaining and/or creating lists of various risks can be very helpful. A couple of excellent older lists are in the articles "Managing Financial Instruments in a Life Company Portfolio" by Paul Kennedy and if I may toot my own horn, my "Risk in Investment Accumulation Products of Financial Institutions." Other excellent resources are Max Rudolph's reoccurring emerging risks survey. Another excellent resource is Google Alerts, which will continually conduct searches against the entire Internet for specific areas of interest.
- You must also know your resource limitations to be able to measure and ameliorate the risk. You don't want to do too much too quickly, and you also should make sure that you have sufficient staff to conduct both the data collection and the key analyses.
- Of course, the most difficult component is to understand the interactions of separate players. If you just spend time creating a list of the players associated with the risk will go a long way to the basic understanding of the environment. Next, you need to know how the players interact. You should think about how greed, ignorance, laziness, fear, and limitations of each player can influence the risk. Your understanding of this psychological network will also allow you to identify new aspects of the risk that you may have not considered. Besides creating this network, another good tool is to use data mining to quantify both the herd and the individual mentality of the players. In the examination of eight years of daily variable annuity transactions against the performance of the stock market, I discovered that the majority of the contract holders moved their money at the most inopportune time (for them), which revealed how much they were motivated by fear. Regarding individual behavior, in another study, we observed that a 457 plan's fund transfer limits were exceeded in one specific state. Upon further examination, a specific county exceeded the limit and it was finally determined that it was due to the behavior of two contract holders. The contract holders wanted to continue to obtain interest on their monies over the weekend, so they transferred all their monies into fixed funds on Friday and back to variable funds on Monday. Another useful data mining result was the determination of brokers from Hell. When we observed dramatic lapse increases within the Broker/Dealer variable annuity business, data mining was used to determine a small group of brokers that were churning the business. Also, I have personally seen the effectiveness of data mining in the discovery of fraud by insurance agents.

When playing the game, you must resist the temptation of only picking the low hanging fruit. You will discover that the continual use of this strategy, will lead to frequent losses. Similarly in risk identification, you may discover that your upper management is interested in a quick turn around so that ERM could be no more than window dressing. As mentioned above, human nature tends to be greedy and lazy because of the desire to obtain the greatest benefit by expending the least effort. You may have observed when privately held companies go public, how

> "You must resist the temptation of only picking the low hanging fruit."

management strategy frequently moves from long range to short range. Also, new, heavily invested, initiatives may take on this same short term philosophy and should be examined closely. Recall in the late 1990s, where international monies were flowing into western economies because of the flight to quality. This was when the LTV ratio requirements were reduced, as well as, the lowering of underwriting standards. The low hanging fruit strategy, also can lead to overconfidence that minimalize deeper issues, just to maintain the status quo. For instance a large number of companies have implemented their Operational Risk programs with only COSO requirements, which has lead to massive under capitalization.

The only way to excel at 'FreeCell' is to play it frequently. By doing so, you develop excellent observational skills and strategies. In the same way, risk identification requires deep thought, observation, and frequent review. It also, doesn't hurt to be both a bit morbid and paranoid. The revision of a quote used by many mathematics teachers, best sums up risk identification—"The only way to do risk identification quickly is to do it slowly." ✦

FOOTNOTES:

1 FreeCell – Copyright 2007 Microsoft Corporation by Jim Horne
2 1993. Proceedings of the 3rd AFIR International Colloquium. pp 665–672.
3 This article is in the symposium proceedings of the same name available from The Actuarial Foundation. For more information, see http://www.actuarialfoundation.org/publications/risk_investment.shtml
4 See http://soa.org/research/risk-management/research-2009-emerging-risks-survey.aspx or contact Max at max.rudolph@rudolphfinancialconsulting.com for further information.
5 See http://www.google.com/alerts.

The New U.S. Earthquake Models: A Wake-up Call to Actuaries?

By Karen Clark

INTRODUCTION

Earlier this year, the two major catastrophe modeling companies, AIR and RMS, within a day of one another announced releases of new earthquake models for North America. The new model versions, based partly on the 2008 U.S. Geological Survey National Seismic Hazard Maps, produce significantly reduced loss estimates for most regions of the United States. While the amount of reduction varies by model, by region, and by type of business, most companies with significant earthquake exposure will see reductions in loss estimates of at least 20 to 30 percent.

Implemented as is, these changes will have enormous implications for company risk management decisions, including earthquake underwriting, capital allocation, and reinsurance purchasing. Company capital requirements will also change if the rating agencies, such as A.M. Best, continue to rely on point estimates of the modeled 250 year earthquake losses in their assessments of financial strength and capital adequacy.

The new earthquake models are just the latest indicators of the fallacy of basing business decisions on point estimates from models with such significant uncertainty and instability. Due to the paucity of earthquake data, particularly in regions outside of California, the catastrophe models cannot provide reliable point estimates of the probabilities of large earthquake losses. The models can provide plausible scenario losses, but there is not enough scientific data to estimate with any degree of accuracy the probabilities of these large losses.

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The new research on which the updated models are based is part of ongoing scientific investigations that will lead to future significant changes, quite probably back up, in the earthquake model loss estimates. This paper explains why and calls for a more advanced and robust approach to catastrophe risk management.

WHY THE MODELS CHANGED

The earthquake models have three primary components—hazard, engineering, and loss. For the U.S. earthquake models, the hazard component is based largely on the U.S. Geological Survey (USGS) National Seismic Hazard Maps. The USGS seismic hazard maps have been revised every six years since 1990 to reflect research that has been published in the intervening years. The first probabilistic seismic hazard map of the United States was published in 1976 by Algermissen and Perkins.

While the maps themselves have not changed radically since 1976, the process for updating the maps has become more sophisticated. Major enhancements have been the inclusion of more published research, additional peer review, and a better, more explicit recognition of uncertainty. For the 2008 report, there were "hundreds of participants, review by several science organizations and State surveys, and advice from two expert panels." The first formal workshops for the latest report were held in 2005.

The conclusions of the 2008 report end with the following statements: "The 2008 National Seismic Hazard Maps represent the 'best available science' based on input from scientists and engineers that participated in the update process. This does not mean that significant changes will not be made in future maps. We plan on holding several workshops over the next several years to define uncertainties in the input parameters and to refine the methodologies used to produce and distribute the hazard information." The report then lists 11 specific recommendations for ongoing research.

NEW MADRID ILLUSTRATION

The potentially most destructive U.S. seismic zone outside of California is the New Madrid Seismic Zone (NMSZ). A series of large earthquakes occurred along the Mississippi River valley between Northeast Arkansas and New Madrid, Missouri in the winter of 1811-12. The largest quake, occurring on Feb. 7, 1812 destroyed the town of New Madrid, and hence the name of this important seismic source zone. While the exact magnitudes of these events are not known, they are believed to be of the largest magnitude events ever to impact the continental United States. While the area was only sparsely populated at the beginning of the 19th century, if these events were to occur today millions of people and trillions of dollars of property value would be impacted. Insured losses could easily exceed $100 billion.

What little information scientists know about these historical events has been derived from newspaper and personal accounts of the damage the earthquakes inflicted. These accounts were used by Otto Nuttli to create the first isoseismal map of the events in 1973, and later work by Arch Johnston formed the basis of the 1996 Seismic Hazard Maps for this region. In this early work, the estimated magnitude used to represent these series of events was 8.0. Since there are no known accounts of other major earthquakes in this region, the only way for scientists to estimate the return period of the 1811-12 events is to find evidence of prehistoric earthquakes. They have done this using paleoliquefaction studies.

When large earthquakes occur, layers of soil can lose shear strength and behave like a fluid. The water pressure in the liquefied layer can cause an eruption of liquefied soil at the ground surface, often resembling a volcano. This can carry large amounts of sand to the surface, covering areas tens of feet or more in diameter, and creating what are known as sand boils. Sand boils on the surface are evidence of recent earthquakes and sand boils buried by sediment over time are evidence of prehistoric earthquakes. Paleoliquifaction studies find the buried layers of sand and attempt to date when an earthquake may have occurred in the past and caused those features. Early paleoliquefaction studies indicated a return period of 1,000 years for events of the magnitude of the 1811-12 series.

By the time of the 2002 report, however, there was a range of expert opinion on both the return period and the maximum magnitude of these events. For the 2002 National Seismic Maps, a logic tree was introduced to weight four possible magnitudes. Along with scientific debate on the maximum magnitude, new paleoliquefaction evidence suggested that the return period might be considerably shorter than previously assumed and on the order of 500 years rather than 1,000 years. The other important component of seismic hazard, ground motion, was also updated in the 2002 report. Specifically, following the logic tree approach, five ground motion attenuation functions were weighted as opposed to two in the 1996 report.

The NMSZ logic tree again expanded in the 2008 report with additional ground motion models, five hypothetical fault scenarios instead of three, more uncertainty around the magnitude, and the introduction of temporal clustering. Evidence suggests that large earthquakes in the NMSZ have occurred in sequences of three events similar to the 1811-12 series. There are four different clustered scenarios in the report, and the clustered and unclustered models are each given fifty percent weight in the logic tree.

Figure 1 shows how the NMSZ assumptions have evolved over time. It's clear that the updates to the seismic hazard maps, rather than being based on definitive new information, are based on new research that reflects the wide uncertainty in this region. Different scientists, using the same limited data, can and do come to very different conclusions. This is illustrated by the multiplying branches of the logic tree and the more explicit treatment of uncertainty. This is the uncertainty underlying the catastrophe models.

THE FALLACY OF RELYING ON CATASTROPHE MODEL POINT ESTIMATES

Clearly, the fallacy and danger of basing risk management decisions, such as capital requirements and reinsurance purchases, on point estimates from models with such inherent uncertainty is indisputable. Yet the current practice is for the catastrophe modeling companies to take the science in the USGS reports, perform their own analyses (different for each modeling company), and update their models to produce new Exceedence Probability (EP) curves. Current modeling practice is for insurance companies to then use point estimates from the new EP curves to make important risk management decisions. One could make the case that this is modeling "malpractice" on the part of the insurers.

To be more explicit using the New Madrid example, there have been only a handful of loss-producing earthquakes in

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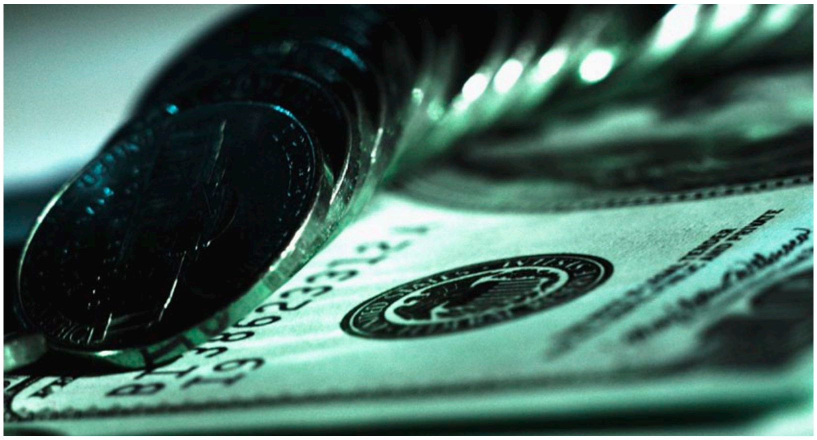

the central United States over the past 200 hundred years. Scientists do not know the magnitudes, exact locations or return periods of these events. Any first year statistics student can tell you that you cannot develop a reliable probability distribution from so few data points with unknown parameters, yet that is exactly what the catastrophe models are attempting to do. Based on this scant data, the catastrophe models are giving companies 1 in 100, 1 in 250 year and other "tail" loss estimates and probabilities frequently with two or more decimal point precision!

To most insurance company executives, the catastrophe models are "black boxes" that spit out answers. There is no transparency around the limited data and wide uncertainty around the model assumptions. Of course, the catastrophe models are far better than the simplistic rules of thumb used before there were models. But certainly we can do better than blindly following the ever-changing numbers produced by the black boxes. The industry is overdue for a more advanced and robust approach to catastrophe risk management.

A MORE ADVANCED AND ROBUST APPROACH

The credibility of the model results can be no greater than the credibility of the least accurately known model component. In the earthquake models, the most uncertain assumptions are the return periods of the large magnitude events and the ground motion those events would cause. While this paper has discussed the NMSZ, this is true for the Pacific Northwest, California and other seismic zones in the United States.

Instead of trying to pinpoint a loss at a particular probability level, which is an exercise in false precision, insurance companies should evaluate a set of representative scenarios for each seismic zone in which they have significant exposure. Insurance companies should have transparency on how their losses change along different branches of the logic trees. They should also have transparency on the estimated loss "footprints" and apply reasonability tests using other information.

A more robust approach to catastrophe risk management utilizes fixed event sets of representative loss scenarios rather than ever-changing "PML" estimates. If, in fact it is possible at all, it will be many decades before the models have significantly less uncertainty with respect to the earthquake peril. In the meantime, fixed event sets allow management to develop and implement effective catastrophe risk management strategies over time.

The U.S. earthquake model updates clearly indicate that it's time for a paradigm shift. It's time to start thinking outside the black box. By now, model users should be sophisticated enough to use information from the catastrophe models intelligently and in conjunction with other information to make more credible and robust risk management decisions. A more balanced, holistic approach that combines the skills of catastrophe modeling, actuarial science, and financial risk management is what insurance companies need to develop and maintain profitable books of catastrophe-exposed property business. ✦

Figure 1: USGS Seismic Hazard Map Assumptions for the New Madrid Seismic Zone (Numbers in parenthesis are weights)

	1996	2002	2008
Fault Sources	3	3	5
Recurrence Interval (Years)	1,000	500	*Clustered (0.5) ** 750,1500 (0.45) 500 (0.45) 1,000 (0.10) *Unclustered (0.5)* 500 (0.90) 1,000 (0.10)
Magnitude	8	7.3 (0.15) 7.5 (0.20) 7.7 (0.50) 8.0 (0.15)	*Clustered (0.5) ** 7.1, 7.3 (0.15) 7.3, 7.5 (0.20) 7.5, 7.7 (0.50) 7.8, 8.0 (0.15) *Unclustered (0.5)* 7.3 (0.15) 7.5 (0.20) 7.7 (0.50) 8.0 (0.15)
Ground Motion Models	Toro, et al (0.5) Frankel, et al (0.5)	Toro, et al (0.25) Frankel, et al (0.25) Atkinson and Boore (0.25) Campbell (0.125) Somerville, et al (0.125)	Toro, et al (0.2) Frankel, et al (0.1) Atkinson and Boore (0.2) Campbell (0.1) Somerville, et al (0.2) Tavakoli and Pezeshk (0.1) Silva, et al (0.1)

** Two magnitudes reflect assumptions for different fault scenarios*

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Gimmel: Second Order Effect of Dynamic Policyholder Behavior on Insurance Products with Embedded Options

By John J. Wiesner, Charles L. Gilbert and David L. Ross

THE GLOBAL FINANCIAL CRISIS THAT STARTED IN 2008 highlighted the importance of higher order and cross Greeks in dynamic hedging programs used by insurance companies to manage risks associated with products such as variable annuities that provide investment guarantees. These guarantees represent embedded derivatives in the liabilities that are often complex, path dependent options. As such, sophisticated models are required to value the option and measure the sensitivity of this value to changes in the underlying,[1] yield curve, and volatility surface as well as the effect of the passage of time.

In general, the first order Greeks that measure the sensitivity to these financial variables (i.e., delta, partial rho, and partial vega) along with the passage of time (i.e., theta), capture most of the change in the option value when volatility is low. During times of higher volatility, second order Greeks such as Gamma, Vomma and Rho Convexity become more important. Following the financial crisis of 2008, more attention is also being given to third order and cross Greeks such as Speed, Ultima, and Vanna.

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Another important consideration for insurance companies is the effect that policyholder behavior will have on lapse rates and the resulting impact this will have on the value of the option. This paper defines a new measure, *Gimmel*, which captures the sensitivity of dynamic policyholder behavior (DPB) on the option value. As more experience data on policyholder behavior becomes available, dynamic policyholder behavior can be better defined as a function of the underlying. This then provides a way to measure the impact on the second order sensitivity, Gamma, to a change in underlying due to dynamic policyholder lapses. This is important because it reflects the fact that the embedded derivative in a variable annuity contract is in effect a put option on a put option.

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Dynamic hedging programs that have been established to manage the risks associated with equity-based guarantees are receiving greater attention. The financial crisis has highlighted that the risks within liabilities with complex guarantees is far more volatile and difficult to hedge than was previously thought. There is growing recognition of the importance of policyholder behavior within the insurance industry. Actuarial bodies are collecting experience data on policyholder behavior and quantifying the impact on the cost of investment guarantees associated with variable annuities and segregated funds.

The growing awareness of these issues and market turbulence has resulted in greater focus on the hedge effectiveness and the risk distribution of the hedging cost. The level of sophistication of dynamic hedging programs and stochastic modeling capabilities of insurers has increased significantly in just the last few years. While many insurers still execute first order dynamic hedging strategies (mostly hedging Delta and Rho), an increasing number are executing or evaluating second and higher order dynamic hedging strategies (including Vega and Gamma as well as third order and cross Greeks). Gamma, when not hedged by actual options, is sometimes hedged by variance swaps. Cross greeks such as delta's sensitivity to volatility may be partially hedged by VIX options. Gamma, third order and cross greeks may also be hedged by complex portfolios of options with multiple strikes and multiple expiries that may or may not actually match the underlying liabilities. It is not the focus of this paper to explain all the various strategies for hedging these greeks, but to highlight the increased sophistication of both the study and management of these complex liabilities.

Many of the models used for simulating stock prices would assume the large movements that occurred in the financial markets to be five standard deviations or higher

FOOTNOTES:

[1] In this paper we will assume for convenience that the underlying is an equity index.

> "Just as Gamma changes the Delta based on in-the-money-ness or out-of-the-money-ness, so likewise would rational policyholder behavior."

events which would not generally be considered in hedging programs. This level of volatility would significantly increase the hedging cost of first order dynamic hedging strategies and severely punish any insurer with a naked short Gamma position.

Not unlike Gamma, there is another factor that can significantly change the Delta of a liability with embedded guarantees—DPB. Just as Gamma changes the Delta based on in-the-money-ness or out-of-the-money-ness, so likewise would rational policyholder behavior (where we define rational[2] to be a policyholder who understands the value of the embedded guarantees within his or her policy). The further in-the-money (ITM) an option is, the closer the Delta gets to one. Similarly, the more in-the-money a guarantee gets, the less likely a *rational* policyholder will lapse.

Conversely, the further out-of-the-money an option gets, the closer the Delta of that option gets to zero, and the further out-of-the-money a guarantee gets the more likely the *rational* policyholder will lapse.[3]

Generally, an insurance policy with a guarantee is considered to be an option and modeled as such. In reality, the fact that the policyholders can lapse their policy means that the policy could also be considered as a consecutive series of options on an option. Each year, the policyholder can choose to continue owning the main option or choose to lapse the policy; the policyholder has the *option* of dropping the policy. Many policies have early termination penalties[4] to recapture some of the embedded value that these secondary options give the policyholders.

If these series of options were utilized by policyholders in a completely rational manner, the effect could be devastating to insurance companies and reinsurers. This stream of options on the main option has the effect of magnifying or compounding the Gamma effect of the original option in the guarantee. It is this effect—this further increase in the negative convexity of the guarantee beyond Gamma—that we have dubbed "Gimmel."

It might be important to distinguish a generic lapse assumption from the dynamic lapse assumption at this point. A generic non-dynamic lapse assumption tends to decrease the liability to the insurance company (i.e., it is beneficial to the company when a policyholder lapses). These kinds of products are known to be "lapse supported," in other words, lapses generally help the insurer by eliminating an obligation that the insurer had had. This sensitivity of the value of the liability with regard to flat-out lapses is quite different than the sensitivity to the *rational utility* of the policyholders. If those very same assumed lapses were to happen ONLY when the guarantee was not in the policyholders

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FOOTNOTES:

2 This definition of "rational" does not include the possibility of liquidity and opportunity issues that may in fact make lapsing a policy and foregoing the embedded value of the guarantee a "rational" decision. As the secondary market for insurance products grows, insurers should be aware of the risk that lapses that would have been "rational" from a liquidity perspective may be curtailed as the secondary market provides liquidity to the policyholder without the policyholder necessarily needing to lapse the policy. Again, this paper is not intended to provide the "right" definition of "rational," but rather to provide a language that can help discussions of changing experience over time. This paper and its example focus purely on the economic value of the guarantee compared to the economic value of replacing the guarantee with separate option trades.

3 Some policies have ratchets built in to minimize how far out-of-the-money OTM the guarantee will get precisely in order to discourage lapses. These ratchets though have an optionality value themselves that must be considered.

4 Well designed early termination penalties should help decrease "short Gamma" on two counts; first by extending the expected duration of the overall "option", Gamma will be decreased as long dated options have less Gamma than shorted dated options, ceteris paribus; and second, the "options on the options" are less likely to be optimally utilized since there is an immediately recognizable cost to lapsing, thereby decreasing "Gimmel" itself. As these two effects will be taking place simultaneously, it may be difficult to separate the two effects. Ideally, a termination provision would encourage lapses when the guarantee is in the money, and discourage lapses when it is OTM.

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advantage, the result of the lapses would be quite detrimental to the insurer, rather than helpful.

However a modeler arrives at the cost of the *rational utility*, and whatever name is given for that cost, that is still not the sensitivity that is "Gimmel." Gimmel rather, is the change in the sensitivity of the value of the liability to changes in the underlying funds.

As an unparameterized definition of this sensitivity of the liability we offer:

Gimmel (𐤂) the change in the Delta of a investment with a guarantee with regard to a change in the underlying due to Dynamic Policyholder Behavior; or, more simply, the incremental change in Gamma due to Dynamic Policyholder Behavior.[5]

Let,
ω = total lapses
$\omega = \omega^b + \omega'$

Where,
ω^b = base lapses that do not vary with underlying
ω' = dynamic lapses in excess of base lapses that are a function of the underlying, in-the-moneyness, and degree of rationality (0% - 100%). Dynamic lapses could also be a function of the price of the option—i.e., vol, T-t, risk-free rate, etc.—and would make Gimmel a function of multiple financial variables, which it could very well be.

Then,

𐤂 $= \delta\Gamma/\delta\omega'$

or

𐤂 $= \Gamma_{\omega} - \Gamma_{\omega b}$

For clarity it could also be expressed:
$\Gamma_{total} = \Gamma_{\omega b} +$ 𐤂

To illustrate this idea, but without the intention of claiming that the method given below is the "right" answer to building a utility function, we constructed a simple example:

Let a policy be written for two years (t = 0 initially) guaranteeing that a $100 portfolio will grow to $105 (i.e., K = 105). The fee of $5.00 is charged outside of the policy; $2.50 at t = 0 and another $2.50 at t = 1

In this simple example let

σ = 10%
r = 2%
dividend yield = 0%.

Also let ω^b = 5% and ω' = 10% x (0 if guarantee is ITM at time t = 1, 1 if guarantee is OTM at time t = 1) so ω=.05 + .10 x (0 if guarantee is ITM, 1 otherwise). In reality this latter function will be decomposed into the rationality factor and ITM, but this example is purposefully simplified.

Further, let average annual lapse be assumed to be 10% (5% + average (0, .1)), since in this example, half of the time ω' = 10% (an up market) and half of the time ω' = 0 (a down market)

100,000 scenarios were generated. All of the cases use the same underlying paths. At time t = 1, the Black Scholes formula was used to value the 105 Put with only one year remaining. If the remaining value of the Put was less than the $2.50 fee for that period, the "rational" policyholders in the GMAB-dynamic behavior case lapse. In other words, 15% (5% + 10%) lapse. Otherwise, only 5% (5% + 0%) lapse.

The cases are:
2 year 105 Put
flat 10% lapse
dynamic lapse of 5% + (10% or 0%)
dynamic lapse shocked 1%; 5% + (11% or -1%)

Additional cases with 20% lapse or 0% lapse (which still "averages" to 10% as do the others)

FOOTNOTES:

[5] Gimmel "𐤂" comes from the Phoenician alphabet as opposed to Gimel "λ" from the Hebrew alphabet. The idea being that "𐤂" appears to be more "bent" or more convex than the Greek letter "Γ" to symbolize increased convexity.

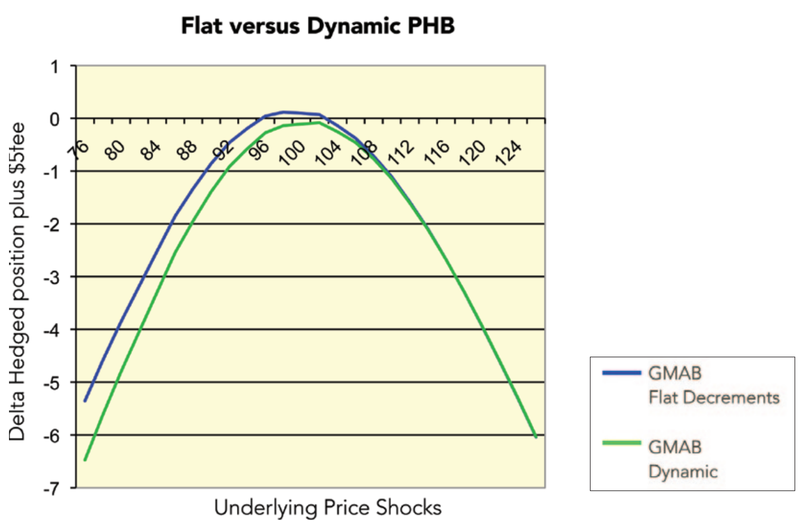
	Lapses				Survivor for Period		
	Flat		Dynamic		Flat	Dynamic	
	ωb	ω'	OTM ω	ITM ω	Sx	OTM Sx	ITM Sx
Primary Example	5%	0% to 10%	15%	5%	0.9	0.85	0.95
Example Shocked	5%	-1% to 11%	16%	4%	0.9	0.84	0.96
"Super Rational"	5%	-5% to 15%	20%	0%	0.9	0.8	1

Results:

	105 Put	GMAB-static behavior	GMAB-dynamic behavior	GMAB-shocked 1%	GMAB-super rational
Value	5.999	4.859	5.113	5.163	5.366
Delta	-50.478	-40.887	-42.897	-43.299	-44.906
Gamma	2.597	2.104	2.182	2.198	2.26
Gimmel	na	0	0.078	0.094	0.156

Gimmel does not exist for the Put itself; Gimmel is, by definition, 0 for the flat or static lapse assumption case; in the three other cases Gimmel is the difference between the Gamma of each case minus the Gamma of the flat or static lapse assumption.

The following chart shows the plotted values of a delta hedged policy shocked by price movements for both the flat lapse assumption and a dynamic lapse assumption. The blue line shows the flat lapse assumption liability, the green line shows the dynamic lapse assumption. An instantaneous movement will increase the value of the liability (more negative) when there is a dynamic assumption, hence the green line is more negatively convex than the blue line.



1) Option price plotted against stock price for base lapses => curvature = Base Gamma
2) Option price plotted against stock price for dynamic lapses => curvature =Base Gamma + Gimmel

Then the increase in curvature = Gimmel

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We hope that this term "Gimmel" and the concept it is intended to represent will help everyone have a common language in future discussions about this kind of risk. However people incorporate dynamic policyholder behavior into their models, and whatever formulae represent the policyholder utility, we hope that the common parlance is understood by practitioners so that meaningful discussions can take place without requiring that anyone disclose proprietary information about policyholder experience. ✦

APPENDIX: TAXONOMY OF OPTION SENSITIVITY METRICS

Color measures the sensitivity of the Charm, or Delta Decay to the underlying asset price. It is the third derivative of the option value, twice to the underlying asset price and once to time.

Delta measures the sensitivity of the option to changes in the price of the underlying asset.

Delta Decay, or **Charm,** measures the rate of change in the Delta of the option to the passage of time. It is the second derivative of the option value, once to price and once to time. This can be important when hedging a position over night, a weekend or a holiday.

Gamma measures the rate of change in the Delta of the option to the underlying asset.

Lambda is the percentage change in option value per change in the underlying price.

Rho measures sensitivity of the option to the applicable interest rate.

Speed measures the third order sensitivity to price. The speed is the third derivative of the value function with respect to the underlying price.

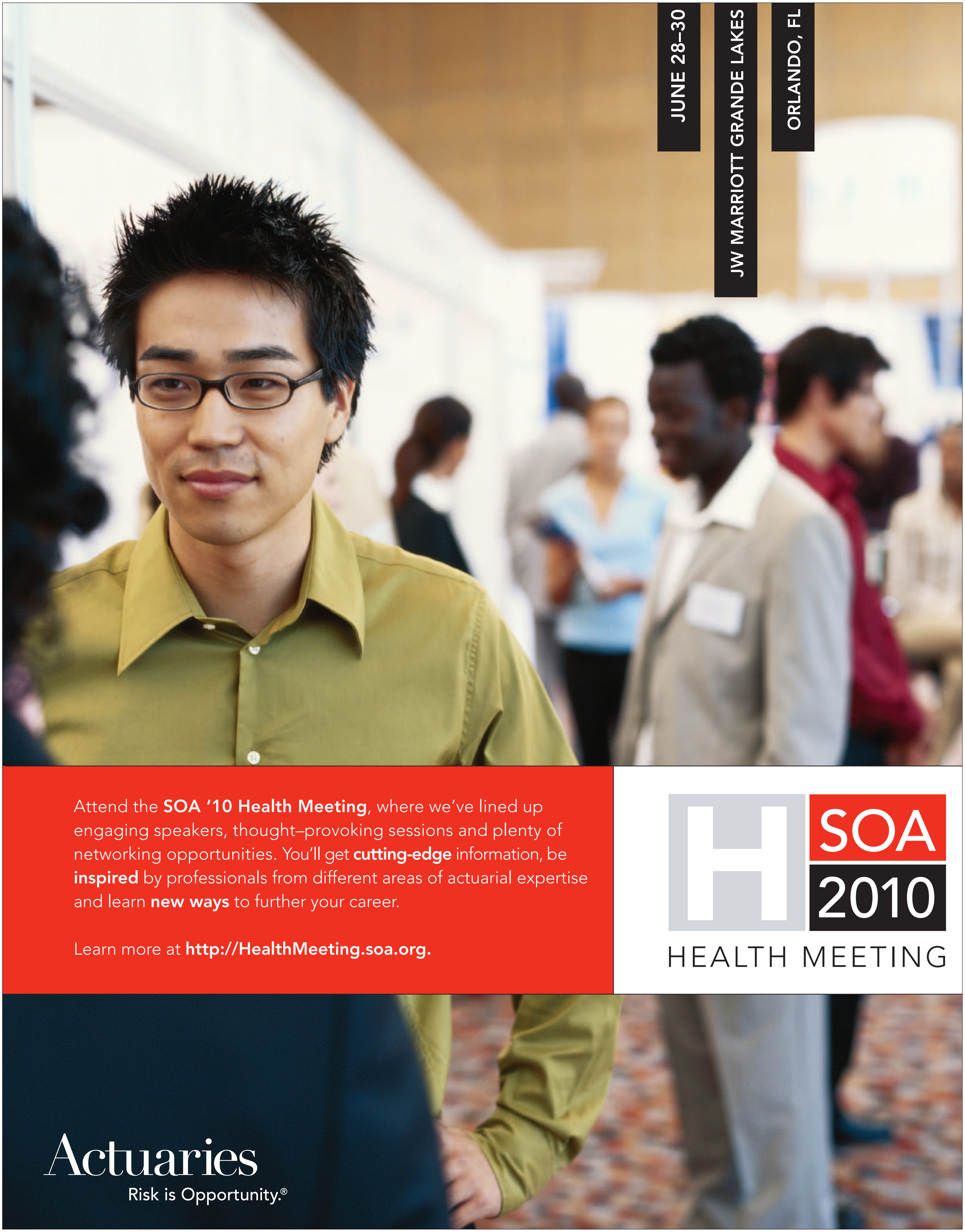
Theta measures the sensitivity of the option to the passage of time.

Vomma or Vega Gamma or Volga measures second order sensitivity to implied volatility.

Vanna measures cross-sensitivity of the option value with respect to change in the underlying price and the volatility, which can also be interpreted as the sensitivity of Delta to a unit change in volatility.

Ultima is considered as a third order derivative of the option value; once to the underlying spot price and twice to volatility.

Vega measures sensitivity to volatility.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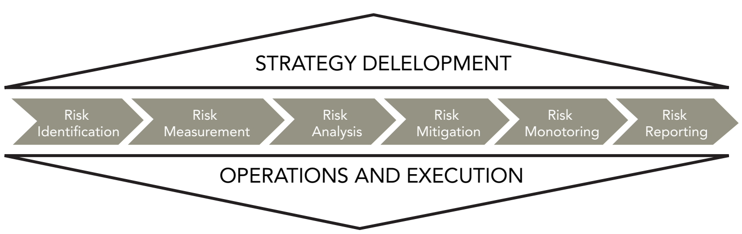
Integrating Risk and Strategy to Derive Competitive Advantage

By Azaan Jaffer

OFTEN RISK MANAGEMENT and business strategy development remain segregated at most of the organizations; even though most Chief Risk Officers and senior executives recognize risk management should be an integral part of the overall business strategy. The integration of risk management within strategy development provides organizations with a broader set of options resulting in significant competitive advantage. The risks and opportunity costs in accepting status quo are too high otherwise. Organizations seeking to integrate the two functions must take deliberate steps to challenge traditional paradigms in order to overcome barriers. Typically risks are evaluated and addressed around the execution of business plans as opposed to evaluating risks associated with the business strategy in its entirety. Evaluation of risks at the execution is important, however to derive optimum impact it is important to evaluate risks at the strategy level also. The figure below illustrates, a robust risk management framework should be integrated at both the strategy development and execution stages. If implemented well, every element of the framework, i.e., risk identification, risk measurement, risk analysis, risk mitigation, risk monitoring and risk reporting should be revealing key insights that would assist in driving major strategic and execution decisions. It is also important to note that the risk management framework can and should be employed at all levels, ranging from transaction, product, process, business unit to enterprise–wide level in order to derive sustainable competitive advantage. In other words, risk management should be an integral component of the organization's culture at all levels.



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This article focuses on risk mitigation strategies and intends to demonstrate how an organization, a financial institution in this case, realized significant positive impact on its bottom line by integrating risk management in its overall business development strategy. One of the key objectives of a risk mitigation strategy is to 'optimize' on the potential risks by deliberately designing appropriate mitigation strategies to address identified risks. Every risk presents potential opportunities if managed pro actively. There are multiple ways to mitigate risks, ranging from risk control, risk retention, risk transfer, risk financing, risk redistribution to risk 'avoidance'. For the most part risk 'avoidance' is not a viable option.

In this case study, the integration process started with a business planning session where business objectives were developed and strategies were formulated to meet these objectives. An element of the strategy was to develop, design and launch a new product. Once initial market research was completed and the results suggested the viability of the product, risk management process was invoked. Key risks inherent in the product were identified, quantified and analyzed. It was important to identify risks through the entire value chain, ranging from product development to fulfillment in order to ensure all potential risks were addressed. Other relevant internal initiatives were leveraged in the risk identification process. Two key risks were identified, quantified and analyzed for this product (Loss T1 and Loss T2). The quantification of the identified risks was based on loss experience of a similar product that was launched in the prior years and supplemented by additional industry loss experience. However, the loss experience was adjusted to reflect the attributes of the new product and the current market and regulatory environment. Based on the underlying data and qualitative insights associated with these two loss types it was determined that there was a potential correlation between these loss types, hence an opportunity to derive additional benefit from portfolio effect. As part of the quantification exercise a stress test of plausible extreme scenarios was also conducted. It is imperative to internalize that risk

> "The integration of risk management within strategy development provides organizations with a broader set of options resulting in significant competitive advantage."

quantification is directionally sound and has to be a means to a bigger end as opposed to an end itself.

The results from the quantitative analysis are illustrated in the chart below.

	Loss T1	Loss T2	Loss Portfolio	Summation	Portfolio Effect
	(1)	(2)	(3)	(4)=(1)+(2)	(5)=(4)-(3)
Expected	$368,744	$239,819	$608,563		
50% Perc	$210,646	$138,674	$438,867	$349,320	$(89,547)
55% Perc	$264,889	$172,586	$510,659	$437,475	$(73,184)
60% Perc	$325,056	$208,745	$588,114	$533,801	$(54,312)
65% Perc	$388,256	$249,302	$679,699	$637,558	$(42,141)
70% Perc	$461,293	$297,227	$777,975	$758,520	$(19,455)
75% Perc	$547,657	$351,646	$884,244	$899,303	$15,060
80% Perc	$645,489	$418,336	$1,021,314	$1,063,825	$42,511
85% Perc	$773,931	$504,180	$1,198,691	$1,278,111	$79,420
90% Perc	$955,857	$618,070	$1,474,463	$1,573,927	$99,464
95% Perc	$1,387,446	$900,506	$1,902,220	$2,287,952	$385,732
99% Perc	$2,147,919	$1,447,883	$2,935,786	$3,595,802	$660,016
99.865% Perc	$3,060,328	$2,215,524	$4,080,463	$5,275,851	$1,195,389
99.9% Perc	$3,095,163	$2,308,212	$4,157,372	$5,403,375	$1,246,003
Note: the correlation between Loss T1 and Loss T2 is assumed to be 0.5.					

Based on the results of the quantification exercise the following key insights were derived and formed the basis for key strategic decisions.

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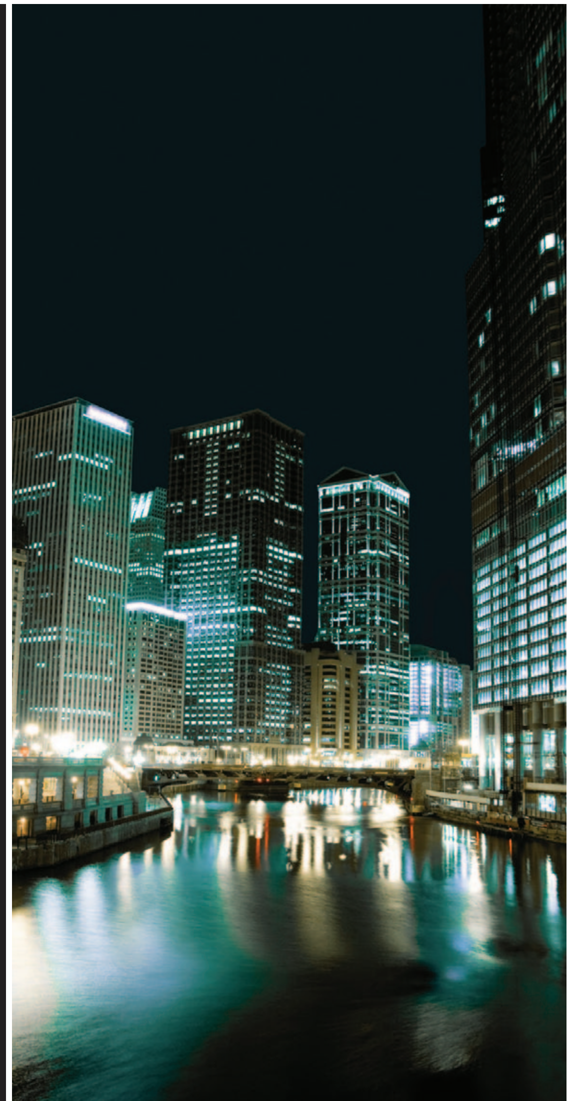
KEY INSIGHTS AND DECISIONS	IMPACT
Incorporating expected and a portion of unexpected losses in the pricing of the product.	Improved profitability of the product without sacrificing market share. Market dynamics were considered in the final pricing. However the key outcome was implementation of risk based pricing.
Fact and analysis based decision to retain risk at 95 percent confidence level; in this case the aggregate annual retention was set at $2,000,000 which was well within the organization's risk tolerance level as opposed to $500,000 in the past.	The higher risk retention levels resulted in 25 percent relief in insurance premium. Also minimized the "dollars traded" with the underwriter for lower level retention. The results from the analysis were also instrumental in negotiating reinsurance premiums.
Credible and defensible capital allocation to the business units.	Capital associated with retained risk was attributed to the appropriate business unit resulting in a more reflective measure of risk adjusted return on capital.
Understanding of underlying key risk drivers associated with various products, processes and channels.	Ability to meaningfully manage risks resulting in a significant decrease in loss experience resulting in reduction of expenses and capital consumption.
Development of Key Risk Indicators (KRI) as a result of the above. These KRIs became an integral component of risk monitoring and risk reporting.	Incorporated KRI in the business unit's risk dash board resulting in pro active management of risks.

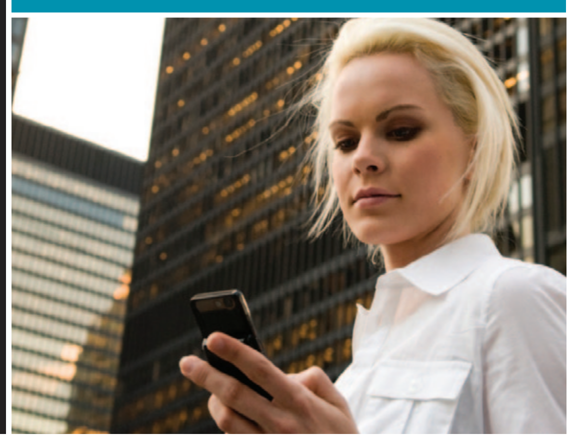
Since the outcome of the quantification exercise resulted in significant positive impact on the bottom line, a similar analysis was conducted for other products resulting in additional relief in insurance premium. In some cases there was a relief of over 30 percent over a span of multiple years. The analysis also resulted in better understanding of the underlying key risk drivers for respective products. Appropriate mitigating strategies were developed and implemented resulting in additional cost and capital savings. Further analysis was conducted to identify potential correlation between loss types amongst products resulting in additional savings.

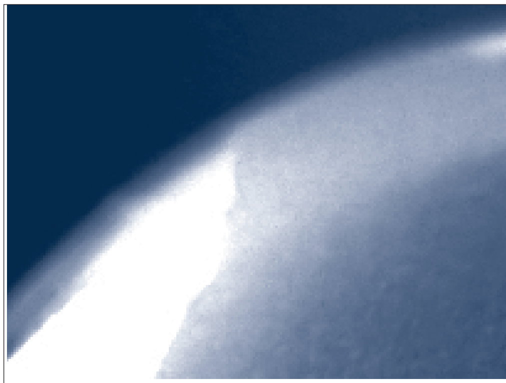
"To derive maximum value from risk management initiatives it is important for organizations to embrace risk management within their culture and not view it as a regulatory imposition."

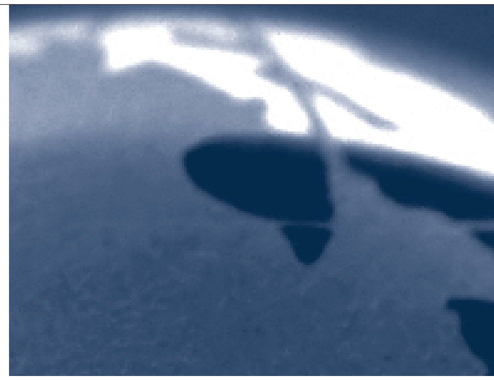
In order to derive maximum value from enterprise wide risk management initiatives, organizations must recognize and embrace that risk management has an integral role at all levels and it should be integrated in its culture. The organization should not view risk management only as a regulatory imposition. If the framework is dynamic and robust and is implemented in the context of strategy development and at the operations and execution level, then most of the regulatory requirements would be addressed. In order to have a dynamic and robust risk management framework it is imperative for organizations to also leverage other relevant internal initiatives, such as SOX, internal audits, Basel II, Solvency II, etc. to minimize redundancies and optimize on the efforts.

This case study reflects the significant value derived by the financial institution in integrating risk management upfront during strategy development which resulted in significant cost savings and a competitive advantage. One of the key success factors in this case was the fact that there was a commitment at the senior level of leadership to integrate risk management at the strategy level and also implementation of a structured methodology to implement all the elements of the risk management framework. ✦









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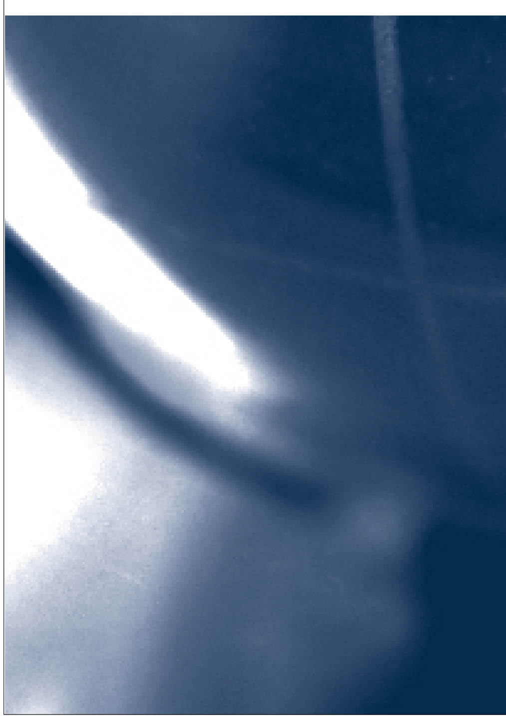

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